

\* *Hemicarpha subsquarrosa*, Nees. Shore of Waushacum Pond, in sand; and shore of Gleason's Pond, in gravel. In the latter situation it is matted with, and almost hidden by, plants of *Fimbristylis autumnalis*, Roem & Schutt.

\* *Eleocharis palustris glaucescens*, Gray. Abundant on the shore of Waushacum Pond.

*Cladium mariscoides*, Torr. Very abundant on margin of Waushacum, with *Carex filiformis*, *Carex riparia* and *Eleocharis palustris*, forming a belt for long distances, from ten to twenty feet broad. The *Cladium* is by far the most conspicuous element.

\* *Panicum xanthophysum*, Gray. Not uncommon.

\* *Panicum macrocarpon*, LeConte. After consulting the specimens in the Gray Herbarium and comparing with the descriptions in Britton & Brown's Illustrated Flora, I am convinced that most of what passes for *P. latifolium* from New England is properly referred to *P. macrocarpon*. Certainly my specimens belong there.

\* *Panicum sphaerocarpon*, Ell. Abundant.

\* *Panicum Atlanticum*, Nash. Not common.

\* *Panicum boreale*, Nash. Not common.

\* *Panicum Columbianum*, Scribn. Common.

\* *Panicum pubescens*, Lam. Common.

Not all these *Panicums* are actual additions to the list, though the names are new there, being the result of recent special work on the perplexing dichotomum group.

\* *Bromus brizaeformis*, Fisch. & Meyer. Collected for three years past on a dump near Leonard's Pond.

FRAMINGHAM, MASS.

## THE POLLUTION OF WATER-SUPPLIES BY ALGAE.

G. T. MOORE.

THE question of a pure water supply is one which is of so much importance and interest that it can hardly be said to apply to any special locality. Throughout the country more and more attention is being given to it by both engineers and biologists, and new problems are constantly developing with regard to it. To Massachusetts, however, is due the credit of being the first state to begin any systematic

study of the various organisms found in water-supplies, and it is through the efforts of the Massachusetts State Board of Health, that most of the information we have on the subject has been acquired. Up to the present time, the work has consisted largely of a determination of the occurrence, quantity, and effect of the algae, while the question as to the best way of preventing their appearance is one still to be answered.

As a rule, the larger and more easily recognized algae do not produce any pollution. Such forms as *Spirogyra*, *Zygnema*, *Cladophora*, *Conferva*, etc., while they may occur in ponds and reservoirs to a considerable extent are not likely to cause trouble unless it be a mechanical one. The case is different, however, when we come to some of the more minute species. Here the inconvenience and damage caused is frequently great, and while they do not actually poison the water it is rendered so disagreeable and unfit for use that, temporarily, the effect is much the same. Perhaps the best known forms responsible for this contamination are the members of the group popularly called the "blue-green algae." These plants, the *Cyanophyceae*, are considered by some to be outside the limits of the true algae, and are called *Schizophyceae*, which are classed, together with the bacteria, under the *Schizophyta*. They certainly greatly resemble the bacteria both as to their morphology and general mode of life, and one reason the bacteria are now considered plants is because of the similarity between them and the *Cyanophyceae*.

The forms of the blue-green algae are extremely various. Sometimes the plant consists of a single cell, less than  $\frac{1}{100}$  mm. in diameter, which may or may not be united into colonies of considerable size. Again the plants are made up of bead-like chains of cells such as are found in the nostocs; or the filament of cells may be of the same diameter throughout its length, as in the oscillatorias. During the summer, especially, these algae multiply very rapidly by the simple division of their cells, and under favorable conditions are apt to occur in such quantities as to produce the so-called "pig-pen" odor. This is essentially the result of decomposition and is due to the breaking up of compounds of sulphur and phosphorus in the presence of a high percentage of nitrogen. In addition to the trouble caused by the decay of these forms, there are some species which have what may be called a natural odor, which is generally due to an oily substance contained within the cells of the plant. This oil may be liberated in various ways, and then the water becomes charged with the characteristic

odors, which have been likened to that of grass, fish, ripe cucumbers, candied violets, etc. Sometimes the odor is accompanied by a fishy, oily taste, and there are algae which impart a characteristic taste without any odor. *Anabaena* is one of the most troublesome genera producing these natural odors. It gives rise to a strong scent not unlike the odor of raw green corn, or nasturtium stems. *Coelosphaerium*, which frequently occurs with *Anabaena*, is also the cause of a distinct odor and taste.

Jamaica Pond, at Jamaica Plain, Mass., while not a part of any water-supply, is interesting, because it illustrates to what an enormous extent a member of the *Cyanophyceae* may multiply in its water, and render it unfit for use merely because of the quantity of vegetation it contains. In the spring, this pond may be seen to assume a light reddish-brown color. As the season advances the water becomes darker and darker until it is of a decided chocolate hue, — certainly not a shade which would suggest that it was affected by a “blue-green” alga. Such is the case, however, for microscopic examination shows that the water is filled with the minute filaments of *Oscillatoria prolifica* Gomont. This plant is made up of a series of cells not over  $\frac{1}{200}$  mm. in diameter, and except for its color presents the usual appearance of an oscillatoria. The question as to what gives the cells their chocolate color has been the subject of some controversy. It is not yet definitely settled, but it seems probable that the change in hue from blue-green to reddish brown is due to the presence of gas vacuoles near the surface of the cells which produce an optical effect sufficient to give the chocolate appearance. The reddish-brown color is not an unusual one among the *Cyanophyceae*, it being found in a number of genera besides *Oscillatoria*, one of the most notable examples being that of *Trichodesmium erythraeum* Ehrenb., the periodical occurrence of which has given the Red Sea its name.

It was formerly supposed that the minute plants belonging to the *Diatomaceae*, had no injurious effect upon water, and, although they are frequently the most common vegetation found in ponds, they were passed over as being unimportant. But in recent years it has developed that certain diatoms are capable of imparting an oily, vegetable taste, while others produce a distinct aromatic odor. *Asterionella*, a linear form, inflated at the ends and usually symmetrically arranged in the shape of a star, gives rise to a “rose-geranium” odor which may become fishy as the number of plants increase. There are

other diatomes which possess a characteristic disagreeable taste, and numerous forms cause serious trouble in water that is to be used in the manufacture of paper.

Perhaps the organism which produces the most unpleasant and disagreeable effect upon the various water-supplies in New England is *Uroglena*, a form which although claimed by zoölogists, has probably just as good a right to be studied by botanists. This occurs only during the colder months of the year, being most luxuriant when the water is covered with ice. In a very general way it may be said to resemble a volvox colony, that is, it consists of a gelatinous sphere in the periphery of which are embedded numerous green cells. These cells are each provided with a red spot and a pair of cilia of unequal length and these by their undulatory motion revolve the colony through the water with considerable rapidity. The pollution which *Uroglena* produces is caused by an oil contained in the form of small globules in each cell. These cells are so delicate that the slightest change in the condition of the water is apt to bring about their disintegration and thus the oil is liberated, giving to the water a most disagreeable oily, fishy taste. This last season has been a particularly favorable one for *Uroglena* in Massachusetts, it being especially troublesome at Hingham, and occurring at various other places.

The question of how to prevent the appearance and growth of algae in water-supplies is, of course, an important one. While they can not be said to be actually injurious to health and there is no occasion for the alarm, which is sometimes aroused by newspaper articles, the inconvenience they cause is so considerable and the contaminated water so disagreeable that a practical means of removing them is much to be desired. Thus far but little has been accomplished. It is known, of course, that the freer from organic matter a reservoir can be kept, the less likely it is to become infected by algae, and large sums of money are expended by water-boards in an effort to clean the ponds and reservoirs which furnish the supply of water. But when we consider that any good water contains all the elements necessary for the growth of these plants and that most of them have the power of forming resting spores, which will tide them over unfavorable conditions and which can be carried great distances by the wind or other agencies, we see what a difficult problem the whole subject presents. By obtaining a sufficiently large number of statistics with regard to the exact conditions under which these organisms occur and by finding out through

laboratory cultures, the most and least favorable circumstances attending their growth and reproduction, some rule may perhaps be deduced, some combination of temperature and nutrient solution, that will make it possible at least to predict the appearance of objectionable forms. Arrangements could then be made for shutting out that particular part of the supply and preventing the contamination of all the water.

## EXCURSIONS OF THE JOSSELYN SOCIETY.

M. L. FERNALD.

DURING the field-excursions of the Josselyn Botanical Society of Maine, at the annual meeting in Waterville, August 30 to September 2, many phanerogams of unusual interest were collected in Waterville, Winslow, and Belgrade. Three plants not before detected in the state were found: *Rhynchospora capillacea*, Torr., var. *leviseta*, Hill, in crevices of wet calcareous ledges by the Kennebec, Winslow; *Carex granularis*, Muhl., var. *Haleana*, Porter, common on ledgy shores of the Kennebec; and *Eupatorium purpureum*, L., var. *amoenum*, Gray, scarce, by the Kennebec, Waterville; the two former not previously known in New England. Two more species, not yet satisfactorily determined, may be new to the state. Two other plants, not before listed from Maine, though formerly collected at other stations in the state, are *Cyperus aristatus*, Rottb., abundant on sandy and gravelly banks of the Sebasticook at "Beulah," Winslow; and *Circaea intermedia*, Ehrh., in river thickets along the Kennebec, Winslow. This interesting *Circaea*, which in central Maine seems to replace the more southern *C. Lutetiana*, is a common European type, but it has never been recorded in America. The species occurs also in Piscataquis and Penobscot counties, the earliest collection having been made by the Rev. A. P. Chute, in 1847, near Hunt's, on the east branch of the Penobscot.

Some specially noteworthy plants, not before recorded from the Kennebec valley, were *Woodwardia virginica*, Smith, abundant in a bog, Belgrade; *Juncus alpinus*, Vill., var. *insignis*, Fries, in crevices of calcareous ledges by the Kennebec, Winslow; *Quercus macrocarpa*, Michx., abundant about "Beulah," also a single tree by the river, Waterville (formerly reported by Prof. E. W. Hall); *Aster novae-angliae*, L.,